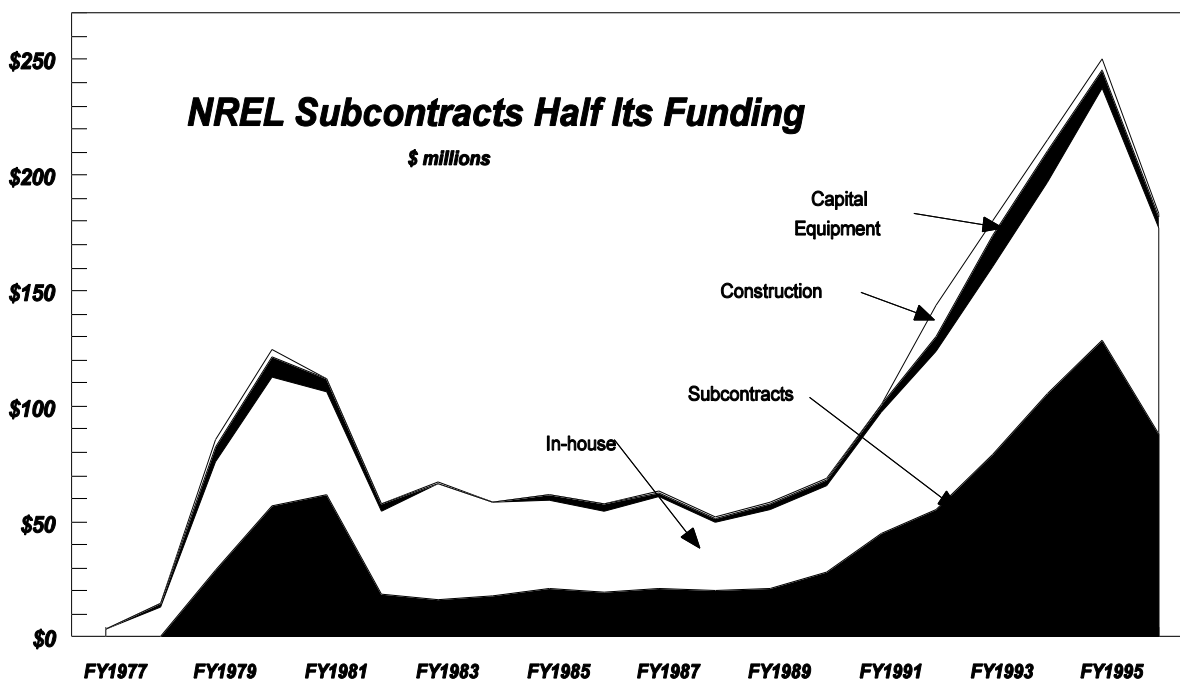


## Partnerships

Partnerships are vital to the success of both NREL and EE. One of the critical elements DOE has established for its laboratories is to be "integrated with the nation's R&D enterprise. The laboratories will be recognized as having strong, mutually supportive links to other agencies, universities, and industry." (*Strategic Laboratory Missions Plan—Phase I*, July 1996, Volume 1, page 23.) NREL currently has partnership agreements of some type with about 250 industry partners, 70 universities, and 80 not-for-profit organizations.

Well-managed partnerships bring benefits to all parties involved. For example, partnerships between NREL and universities bring broad basic science expertise to a problem, provide new ideas to stimulate NREL's own scientists, and provide funds for the education of the nation's scientists and engineers. Partnerships among NREL, energy efficiency and renewable energy companies, and potential end users allow private companies to minimize the risks they face; bring the experience of NREL's scientists and engineers to bear on industry's technical problems and end users' needs for new applications and systems; and provide guidance to NREL and DOE/EE on the best directions for R&D programs.

As shown in the graph below, NREL typically invests 35%–60% of its budget in research subcontracts with its industry and university partners; many of these subcontracts are cost-shared



as much as 50%. The goal of these subcontracts is to leverage the nation's investment in renewable energy and energy efficiency research by encouraging American industry and universities to participate in the development of these technologies. NREL's research subcontracts nurture the most innovative concepts and facilitate cross-fertilization among these concepts, wherever they may be conceived. These subcontracts are discussed more below under the headings "Industry Partnerships" and "University Partnerships."

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**NREL currently has partnership agreements with 250 industry partners, 70 universities, and 80 not-for-profit organizations.**

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In a less direct way, partnerships allow NREL to develop the relationships that can lead to more leveraging of federal dollars. Partnerships also help to raise the awareness of the value and applicability of energy efficiency and renewable energy technologies among policy makers, end users, and business leaders.

NREL intends to focus its efforts on expanding its existing network of partnerships. Specific groups discussed below include industry, universities, the financial community, state and local government stakeholders, and the international community.

## ***Industry Partnerships***

NREL's Business Ventures Center serves as the focal point for traditional technology transfer mechanisms and the place where innovative business partnerships with the Laboratory are formed. The Center oversees and facilitates NREL-wide technology transfer activities: cooperative research and development agreements (CRADAs), work-for-others (WFO) agreements, licensing, and patenting activity.

The Center ensures that these agreements serve the interests of NREL, Midwest Research Institute, DOE, and industry partners. In addition to these mechanisms, subcontracts with industry partners remain vitally important for balanced and effective R&D programs, and user facilities are also becoming increasingly important in NREL's partnerships with industry.

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**Industry CRADA partners have contributed \$2.68 for every \$1.00 invested by the federal government.**

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Under the National Competitiveness Technology Transfer Act of 1989 the Laboratory was granted the authority to negotiate CRADAs with industry partners. This authority 1) permits the NREL Director to form licensing agreements with private partners, 2)

requires the approval of proposed CRADAs by DOE within 120 days, and 3) protects data arising from the agreement for up to 5 years. NREL's CRADAs represent a broad spectrum of industry interest—from Fortune 500 companies to small businesses. To date, NREL has 52 CRADAs with industry partners involving many different technologies. NREL has contributed \$21.9 million to this work and industrial partners have contributed \$58.7 million, bringing the total

value of these cooperative agreements to \$80.6 million. Industry partners have contributed \$2.68 for every \$1.00 invested by the federal government.

In a CRADA, the partners agree to work collaboratively on a common research problem, generally with no funds exchanged among the partners. In subcontracts, the subcontractor agrees to perform

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**Many of NREL's highly specialized research facilities are available to qualified users from industry and universities.**

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needed R&D, and is paid from 50% to 100% of the cost of the work. NREL spent \$106 million, 51% of its total FY 1996 expenditures, on industry subcontracts in FY 1996. Industry subcontracts fund the applied research necessary to develop innovative,

manufacturable, and marketable technologies, and complement both university subcontracts and in-house Laboratory research. In addition, subcontracting with industry helps support the skilled workforce and industrial infrastructure necessary for new technologies to have a fair opportunity in the competitive marketplace.

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**Industry subcontracts fund the applied research necessary to develop innovative, manufacturable, and marketable technologies, and complement both university subcontracts and in-house Laboratory research.**

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Work paid for by non-DOE sponsors, called "work for others" (WFO), is another important mechanism for transferring laboratory technology. In WFO agreements, non-DOE sponsors (companies, other agencies, and nonprofit sponsors) pay NREL to work on specific R&D projects related to NREL's mission. In FY 1996, 31 new WFO agreements with other government agencies, industry, and universities totaled \$1.8 million. NREL has streamlined the processing of these agreements.

Many of NREL's highly specialized research facilities are available to qualified users from industry and universities. NREL staff provide support to outside researchers using these facilities, including the National Wind Technology Center for wind energy R&D; the Alternative Fuels User Facility for ethanol biotechnology process development; the Outdoor Test Facility for hardware testing under a broad variety of environmental conditions; the Thermal Test Facility for buildings research; the Solar Energy Research Facility for photovoltaics and related research and testing; the Solar Furnace and the

NREL works with many U.S. companies to help them develop technology, often through subcontracts; this is a process facility for Solar Cells, Inc. that makes cadmium telluride solar panels. (Photo - Solar Cells, Inc)

Thermochemical User Facility for industrial process research; and the Solar Radiation Research Laboratory for characterization of sunlight.

NREL continues to use its Bayh-Dole authority to retain title to its inventions and to ensure that the inventions enter wide-scale use as quickly and effectively as possible. Patent activities continued to increase and FY 1996 yielded 52 inventions recorded, 14 patent applications filed, 69 patent

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**Patent activities and license agreements  
continue to increase . . .**

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amendments, and 57 filings in foreign countries. During 1996, ten license agreements were signed. License agreements have increased significantly, with 19 signed in FY 1995 and FY 1996; only eight had been signed in all the previous years of the laboratory.

NREL plans to increase the pace of technology transfer through licensing to secure more external revenue streams. The Laboratory has begun a market assessment of NREL's intellectual property portfolio; a gap analysis will determine where NREL intellectual property might be combined with intellectual property from other national laboratories to create a more market-ready technology. NREL aggressively evaluates its new technologies to determine their level of technical maturity and/or readiness, seek private companies interested in commercializing NREL technology, and explore innovative ways to execute the license agreements for the benefit of NREL, DOE, MRI, and the licensee.

In support of this effort, NREL is working with the Colorado Innovation Foundation, a local business incubator, to help Laboratory researchers conceptualize, write, and produce business plans and assist with associated market assessment activities for promising NREL technologies. Outside business incubators, local business schools, and other outside business development and market assessment resources support NREL's own business development staff. Establishing innovative linkages with members of the scientific, financial, and business community helps the Laboratory leverage the available financial and staff resources, and expand NREL's partnership and collaborator network.

An initial summary comparison of the technology transfer/commercialization mechanisms employed by other national laboratories has been completed. This comparison will evolve into an innovative new venture program for NREL to expand opportunities to leverage federal funds. A robust and broadly expanded portfolio of innovative funds-in approaches is planned as one of the most effective ways to expand NREL's business development activities across the Laboratory.

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**The Laboratory has begun a market  
assessment of NREL's intellectual property  
portfolio...**

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## ***University Partnerships***

Universities have been key partners with NREL since the beginning of the Laboratory in 1977. Through subcontracts, university partners conduct research in the basic science advances needed to support the applied research tasks undertaken by NREL and its industry partners. NREL spent \$8.5 million, 4% of its total FY 1996 expenditures, on university subcontracts in FY 1996.

Universities also provide postdoctoral students and visiting scientists to enrich the Laboratory scientific expertise. Many of these scientists have expertise in fields related to solar technologies, and with this broad knowledge, contribute creative ideas to NREL's programs. In return, the basic science that underpins NREL's advances in solar energy provides a fertile and exciting field for education of future scientists.

Students at South Carolina State University inspect solar radiation measurement equipment, one of several universities providing data to NREL for solar radiation assessment. (Photo - Tom Stoffel, NREL)

Universities are also a key resource for outreach and broader education related to renewable energy technologies. Leaders from locales surrounding a prestigious university use the university for expert advice. The community and press near the university also draw upon the expertise, resources, and interests generated at the school.

To further these partnerships, NREL will seek to increase the number of sabbatical visitors from universities to NREL. In turn, the universities will benefit from more interactions with NREL researchers.

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**The basic science that underpins NREL's advances in solar energy provides a fertile and exciting field for education of future scientists.**

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## ***Financial Community***

Partnerships with the financial and business community help DOE and NREL with project demonstrations and implementation, the growth of fledgling companies, and the improvement of NREL's understanding of the economic and institutional considerations in technology development.

NREL and MRI sponsor Enterprise Growth Forums to help NREL's industry partners identify opportunities to enhance the growth and strength of their businesses. These two-day meetings include a panel of venture capitalists, financial experts, and other business specialists who will help evaluate the opportunities for growth presented by representatives of small renewable energy companies. These companies receive R&D funding for collaborations with NREL and DOE and are interested in exploring innovative ways of bringing their technologies to the marketplace. Seven Forums have been held to date (December 1996) involving more than 50 small renewable energy companies.

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**NREL and MRI sponsor Enterprise Growth Forums to help NREL's industry partners identify opportunities to enhance the growth and strength of their businesses.**

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The specific objectives of the Forum are:

- To familiarize venture capitalists and other financial experts with business opportunities in renewable energy and related technologies. The focus is on technologies that NREL's industry partners have identified as approaching commercial readiness
- To familiarize NREL's industry partners with innovative strategies for business growth
- To help establish a dialogue and form working partnerships between members of the financial community and the renewable energy industry

The NREL/MRI Enterprise Growth Forums bring together U.S. energy efficiency and renewable energy companies, venture capitalists, bankers and public officials for hands-on learning and networking. (Photo - Warren Gretz, NREL)

As a result of presentations made and information exchanged at the Forums, several business collaborations have been established involving a variety of renewable energy applications. Two business plans have been rewritten and presented anew based on insight and feedback received at the Forums. Potential collaborative relationships are being explored by a number of other Forum participants.

A number of funding strategies, including sponsorships (both private and federal) and DOE programmatic funding are being pursued to ensure continuation of NREL Enterprise Growth Forum activities.

## ***State and Local Government Partnerships***

State and local government entities are highly promising partners in NREL's mission to facilitate commercialization of renewable energy and energy efficiency technologies. State universities and

other research institutions (a number of which are underwritten by electric utility fees) conduct applied research in energy efficiency and renewable energy that often complements NREL's work.

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**State and local governments can be especially effective partners in facilitating end-use adoption of new technologies.**

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States can also be effective partners in stimulating the manufacture of technologies developed in the Laboratory. State and local government entities are in business to serve their corporate citizens and can help NREL identify partners—as well as marketplace needs and barriers.

State and local governments can be especially effective partners in facilitating end-use adoption of new technologies. Using the various financial and policy tools available to them as stewards of the public interest, they can create incentives—or eliminate disincentives—for the dissemination of new technologies, and actually can help create markets. Governments can use their power as customers to create and move markets, first by demonstrating emerging technologies and then by facilitating large purchases. In this manner, local governments helped move the market for emerging telecommunications technologies and state governments helped fuel the alternative-fuel vehicle market, encouraging Detroit to manufacture the vehicles by aggregating their purchase orders.

In the energy arena, the preponderance of authorities lie with the state governments. State governments write building codes (which local governments enforce); states regulate the utility industry and are writing the restructuring rules; states create tax incentives; states and localities delineate enterprise zones.

This suggests the importance of making sure that state legislators, in particular, are up-to-date on the state of renewable energy technologies and can facilitate their implementation while exercising their various authorities. Finally, at a time of declining budgets, state and local governments are promising partners for sharing the cost of commercialization, with promising opportunities for leveraging government funds.

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**State energy offices, with their complementary mission to NREL's, are key partners . . .**

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All 54 states and territories possess a federally funded state energy office. Created by the U.S. Congress as a national security precaution in the wake of the 1973 Arab Oil Embargo, state energy offices promote independence of overseas energy suppliers that, once again, could hold the country hostage at their whim. This translates into a mission to promote energy efficiency and alternative domestic energy supplies. State energy offices, with their complementary mission to NREL's, are key partners targeted by NREL.

Sustainable Technology Energy Partnerships (STEP): STEP was initiated as a pilot project in 1994 to demonstrate the market for national laboratory expertise in the states and to develop a workable model for future interactions. Twenty-eight state energy offices committed to match NREL resources and partner with the Laboratory to conduct projects in wind energy, alternative fuels,

photovoltaics and biomass in their states. NREL's \$3-million contribution leveraged a total commitment valued at more than \$14 million in the pilot effort.

Incorporating lessons learned from the pilot, STEP-2 was undertaken in 1996. Dramatically reduced funding mitigated against the funding approach employed in the pilot. Instead, STEP-2 is a no-funds-exchanged research partnership, with state energy offices and their partners matching the value of the NREL research effort requested. Twelve states currently are partnering with NREL on 14 projects whose total value approaches \$4 million, with NREL contributing \$1 million of research resources.

**State and Local Partnerships Advisory Board:** Created in 1995, the Board consists of 16 elected and appointed state and local government officials from around the country. Its purpose is to provide independent advice regarding resources available to enhance and complement NREL's work, potential private-sector partners, research needs in the marketplace, and operating changes needed at the Laboratory for optimal relationships with state and local government partners. The Board has provided specific advice regarding opportunities for NREL to partner with, and leverage the resources of, state and local government entities.

**Twelve states currently are partnering with NREL on 14 projects whose total value approaches \$4 million.**

**The Energy Institute:** The restructuring of the electric utility industry provided the impetus for this joint effort with NREL's economic analysts and the National Conference of State Legislatures. State legislators from six states attended a two-day forum in 1996 to study the regulatory, economic, and policy issues associated with restructuring, as well as to learn about the status of renewable energy technologies and explore potential roles for these technologies in a restructured utility environment.

**On-Site briefings for officials:** NREL hosts on-site briefings for state energy office directors and program managers, state land commissioners, state legislators, students, and community leaders from selected communities, and many others. Tours and briefings are designed for the specific interests and needs of the visitors, with the intent of leading to action when the visitors return to their home states. Among the outcomes of such briefings have been the creation of legislative studies and the inclusion of energy-efficient and renewable energy technologies in the construction of state buildings.

The mayor of a Colorado city inspects one of 40 solar panels providing electricity to a park irrigation project. NREL works with state and local governments in a variety of effective ways. (Photo - Warren Gretz, NREL)

Colorado Assistance: While NREL is a national resource, it also avails itself of opportunities to be a "good neighbor" in the locale in which it is situated. NREL responds to local needs and contributes to policy discussions related to market conditioning and other issues related to the adoption of Laboratory-developed technologies. The Laboratory participates in the Colorado Governor's Renewable Energy Task Force and is represented in a number of state associations relevant to the commercialization of renewable energy technologies, such as the Colorado Renewable Energy Society, Colorado Environmental Business Initiative, and Colorado Center for Environmental Management.

The trend toward decentralization of governmental functions is expected to continue. Consequently, NREL plans to maintain its fundamental mission of developing partnerships with state and local government entities and associations. However, it will segment and target audiences within these venues as appropriate according to circumstances.

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**While NREL is a national resource, it also avails itself of opportunities to be a "good neighbor" in the locale in which it is situated.**

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The Laboratory will continue to partner both with individual states and localities, as well as with associations that represent state and local government decision makers. Likely partners include the National Association of State Energy Officials, National Conference of State Legislatures, National

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Association of State Regulatory Utility Commissioners, Interstate Renewable Energy Council, regional energy associations such as the Southern States Energy Board and the Western Interstate Energy Board, DOE's State Energy Advisory Board, associations of Land Commissioners, the National League of Cities,

and the Energy Task Force of the Urban Consortium. NREL will be proactive in developing coalitions around issues as they arise, and will increase the Laboratory's visibility and presence locally and in the region.

State legislatures figure prominently in future plans. NREL will continue to partner with the National Conference of State Legislatures to bring legislators to the Laboratory, where they can acquire first-hand experience with renewable energy technologies and make whatever policy decisions seem appropriate in their own states.

## ***International Community***

Current national energy policies strongly support partnerships with the international community, particularly in developing countries. The National Energy Policy Plan says "In working toward sustainable international energy development, the Administration will encourage continued

improvement of alternative energy and energy-efficiency technologies; world-wide use of U.S. energy technologies; broad dissemination of environmental technologies; and strong partnerships with energy officials around the world."

The largest and fastest growing markets for renewable energy technologies are international. In 1995, 82% of the PV market, 97% of the wind turbine market, and much of the market for biomass power, geothermal power, and other renewable energy technologies was outside of the United States.

Today and for the next decade the market for these technologies will be primarily overseas. For the United States to have a viable renewable energy industry, it must compete in, and capture, a significant share of these international markets.

International renewable energy markets pose unique opportunities and challenges for the United States. The total power market (primarily conventional fossil systems) in developing countries is growing rapidly, with estimates of its value ranging up to \$100 billion per year.

Markets for liquid fuels and transport equipment, building technologies, industrial process equipment, agriculture, and other sectors are larger still, with many opportunities for renewable energy. Capturing even a tiny fraction of these markets would be a huge boost for the renewable energy

### **Village power lights remote corners of the world**

NREL established an initiative in 1993 directed at providing renewable-based electricity to international rural villages. The main theme of the Renewables for Sustainable Village Power is to provide technical assistance to institutions, agencies, and companies interested in evaluating and implementing renewables in villages for electricity.

The activities focus on village applications and needs, rather than a specific technology, although the most emphasis has been on photovoltaics, wind, and hybrids. The key activities include resource assessment, systems analysis of options, comparative assessment model development, pilot-project development, applications development, partnerships, specification development, Internet-based project database and discussion forum, visiting professionals training, and international workshops and conferences.

Currently, NREL has village activities in Brazil, Chile, Argentina, Mexico, Guatemala, Dominican Republic, China, Indonesia, Philippines, India, Russia, South Africa, Ghana, and Alaska. Applications include lighting systems for homes, schools, and health facilities; water pumping; battery charging stations; and whole village systems.

Project partnerships have been established with the World Bank, U.S. agencies, non-government organizations, other national laboratories, and many in-country agencies and organizations. Staff from four NREL centers, four universities, and several visiting countries make up the current village power team at NREL.

industry, and in many cases—particularly in rural areas of developing countries where there is little or no infrastructure today—renewable energy technologies are already the most cost-effective and reliable option. These markets can provide jobs and export earnings for the United States.

The benefits of these international sustainable energy activities are much larger than just narrow commercial advantages for the United States. The environmental benefits of reducing global carbon and acid emissions from conventional fossil-fueled power plants are widely recognized. Other

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**These markets can provide jobs and export earnings for the United States.**

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benefits include improving the urban environment (reducing emissions from vehicles, raising building energy performance, and disposing of urban waste), increasing agricultural productivity to slow the expansion of agricultural lands into important habitat or

fragile lands, and slowing rural to urban migration. By providing reliable sources of power to the 2 billion people that do not now and will not have in the foreseeable future access to conventional grid electricity, renewable energy technologies can improve productivity and give access to communications and information for the first time.

At each stage in the process of moving technologies from basic R&D to large-scale field use, there are appropriate roles for NREL to complement and enhance private-sector efforts: developing, with industry, applications that can help keep the pipeline filled with useful renewable energy products; conducting field engineering; developing pilot projects to build in-country confidence in renewable energy technologies and the capacity to implement them; developing codes and standards; analyzing and helping implement appropriate financial mechanisms; working with multilateral development banks and the private sector for large-scale renewable energy program implementation; facilitating development of distribution infrastructure; evaluating policies and working with foreign governments to level the playing field for renewable energy; and providing a host of technical, training, and other assistance.

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**By providing reliable sources of power to the two billion people that do not have access to grid electricity, renewable energy technologies can improve productivity and give access to communications and information for the first time.**

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NREL is currently working in Argentina, Brazil, Chile, Mexico, South Africa, Ghana, India, China, Russia, and other countries. Activities include resource assessment, development and field testing of new renewable energy systems and applications such as hybrid systems, ice making and battery charging, household- and village-scale pilot projects, technical and policy assistance—including for the development of large-scale renewable energy programs, training, and codes and standards work. Through these and other activities, NREL has forged new relationships with other U.S. federal agencies, multilateral institutions, and other governments and institutions in other countries.

During the next 5 years, NREL's international work will continue building on its highly successful Village Power program (see box), extending the work to additional countries and a broader range of applications. In addition, NREL will be expanding into additional economic sectors. In the

electricity sector, NREL can help make greater use of renewable systems in grid-connected applications, including building-integrated and distributed systems. In the agriculture sector, crop drying, water pumping and other applications present many opportunities for renewable energy. In the buildings sector, building design tools such as Energy-10 and technologies such as transpired collectors, water heaters, and integrated lighting controls have immediate applications in international markets. In the transportation sector, ethanol can solve problems with lead phaseout in gasoline.

These activities will be linked through innovative on-line information resources, design tools, and databases of case studies. These activities will continue NREL's leadership in international renewable energy activities and help build a sustainable energy future.